

11/28/01

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER P/2778-21
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		
INTERNATIONAL APPLICATION NO. PCT/SG99/00048	INTERNATIONAL FILING DATE 28 May 1999	U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 09/980055
TITLE OF INVENTION AN INTERFACE DEVICE		PRIORITY DATE CLAIMED --

APPLICANT(S) FOR DO/EO/US Robert Arthur SAWHILL, Jr. and Paren I. SHAH

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

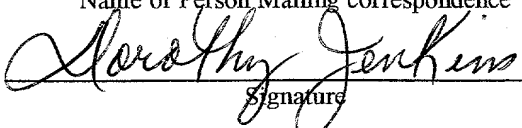
1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). - Unsigned
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance
18. ☐ A second copy of the published international application under
19. ☐ A second copy of the English language translation of the intern
20. ☒ Other items or information:
2 sheets of drawings.
PEFS print form.
7 references.

EXPRESS MAIL CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office Addressee (Mail Label EL 334668891US) in an envelope addressed to: U.S. Patent and Trademark Office, PO Box 2327, Arlington, VA 22202, on November 28, 2001

Dorothy Jenkins
Name of Person Mailing correspondence

Signature
November 28, 2001
Date of Signature

U.S. APPLICATION NO. (If known, see 37 CFR 1.52) 097/980055		INTERNATIONAL APPLICATION NO. PCT/SG99/00048		ATTORNEY'S DOCKET NUMBER P/2778-21	
---	--	---	--	---------------------------------------	--

21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: right;">\$ 1040.00</td> <td style="width: 50%;"></td> </tr> </table>		\$ 1040.00	
\$ 1040.00							
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$			
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$			
Total claims	17 - 20 =	0	x \$18.00	\$			
Independent claims	3 - 3 =	0	x \$84.00	\$			
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				\$			
TOTAL OF ABOVE CALCULATIONS =				\$ 1040.00			
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$			
SUBTOTAL =				\$ 1040.00			
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$			
TOTAL NATIONAL FEE =				\$ 1040.00			
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$			
TOTAL FEES ENCLOSED =				\$ 1040.00			
				Amount to be refunded:	\$		
				charged:	\$		

a. ☒ A check in the amount of \$ 1040. to cover the above fees is enclosed. **Check No.** 7504

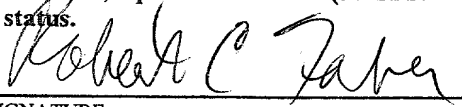
b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0700. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
OSTROLENK, FABER, GERB & SOFFEN, LLP
 1180 Avenue of the Americas
 New York, NY 10036-8403
 Tel: (212) 382 0700


 SIGNATURE
 Robert C. Faber
 NAME
 24,322
 REGISTRATION NUMBER

FORM PTO-1390
(REV. 9-2001)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

P/2778-21

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/980055

INTERNATIONAL APPLICATION NO.

PCT/SG99/00048

INTERNATIONAL FILING DATE

28 May 1999

PRIORITY DATE CLAIMED

--

TITLE OF INVENTION

AN INTERFACE DEVICE

APPLICANT(S) FOR DO/EO/US

Robert Arthur SAWHILL, Jr. and Paren I. SHAH

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). - Unsigned
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance
18. ☐ A second copy of the published international application under
19. ☐ A second copy of the English language translation of the intern
20. ☒ Other items or information:
 - 2 sheets of drawings.
 - PEFS print form.
 - 7 references.

EXPRESS MAIL CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office Addressee (Mail Label BL 334668891US) in an envelope addressed to: U.S. Patent and Trademark Office, PO Box 2327, Arlington, VA 22202, on November 28, 2001

Dorothy Jenkins

Name of Person Mailing correspondence

Signature

November 28, 2001

Date of Signature

U.S. APPLICATION NO. 09/980055		INTERNATIONAL APPLICATION NO. PCT/SG99/00048		ATTORNEY'S DOCKET NUMBER P/2778-21	
---------------------------------------	--	---	--	---------------------------------------	--

<p>21. <input checked="" type="checkbox"/> The following fees are submitted:</p> <p>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</p> <p>Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO..... \$1040.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00</p> <p>International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00</p> <p>International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00</p> <p>International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00</p> <p style="text-align: center;">ENTER APPROPRIATE BASIC FEE AMOUNT =</p> <p>Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 15%;">CLAIMS</th> <th style="width: 15%;">NUMBER FILED</th> <th style="width: 15%;">NUMBER EXTRA</th> <th style="width: 15%;">RATE</th> <th style="width: 10%;">\$</th> <th style="width: 30%;"></th> </tr> <tr> <td>Total claims</td> <td>17 - 20 =</td> <td>0</td> <td>x \$18.00</td> <td>\$</td> <td></td> </tr> <tr> <td>Independent claims</td> <td>3 - 3 =</td> <td>0</td> <td>x \$84.00</td> <td>\$</td> <td></td> </tr> <tr> <td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable)</td> <td>+</td> <td>\$280.00</td> </tr> <tr> <td colspan="4" style="text-align: right;">TOTAL OF ABOVE CALCULATIONS =</td> <td>\$</td> <td>1040.00</td> </tr> </table> <p><input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.</p> <p style="text-align: right;">SUBTOTAL =</p> <p>Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).</p> <p style="text-align: right;">TOTAL NATIONAL FEE =</p> <p>Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +.</p> <p style="text-align: right;">TOTAL FEES ENCLOSED =</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;"></td> <td style="width: 20%;">Amount to be refunded:</td> <td style="width: 20%;">\$</td> </tr> <tr> <td></td> <td>charged:</td> <td>\$</td> </tr> </table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$		Total claims	17 - 20 =	0	x \$18.00	\$		Independent claims	3 - 3 =	0	x \$84.00	\$		MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+	\$280.00	TOTAL OF ABOVE CALCULATIONS =				\$	1040.00		Amount to be refunded:	\$		charged:	\$	CALCULATIONS PTO USE ONLY	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$																																					
Total claims	17 - 20 =	0	x \$18.00	\$																																					
Independent claims	3 - 3 =	0	x \$84.00	\$																																					
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+	\$280.00																																				
TOTAL OF ABOVE CALCULATIONS =				\$	1040.00																																				
	Amount to be refunded:	\$																																							
	charged:	\$																																							

a. ☒ A check in the amount of \$ 1040. to cover the above fees is enclosed. **Check No. 7504**

b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0700. A duplicate copy of this sheet is enclosed.


d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

OSTROLENK, FABER, GERB & SOFFEN, LLP
1180 Avenue of the Americas
New York, NY 10036-8403

Tel: (212) 382 0700


 SIGNATURE
Robert C. Faber
 NAME
24,322
 REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

Robert Arthur Sawhill, Jr., et al.

Date: November 28, 2001

Serial No.: Not Yet Assigned

Group Art Unit: Not Yet Assigned

Intl. Filing Date: May 28, 1999

Examiner: Not Yet Assigned

For: AN INTERFACE DEVICE

Asst. Commissioner for Patents
Washington, D.C. 20231**PRELIMINARY AMENDMENT**

Prior to examination please amend the application as follows.

FEE CALCULATION

In the event the actual fee is greater than the payment submitted or is inadvertently not enclosed or if any additional fee during the prosecution of this application is not paid, the Patent Office is authorized to charge the underpayment to Deposit Account No. 15-0700.

CONTINGENT EXTENSION REQUEST

If this communication is filed after the shortened statutory time period had elapsed and no separate Petition is enclosed, the Commissioner of Patents and Trademarks is petitioned, under 37 C.F.R. § 1.136(a), to extend the time for filing a response to the outstanding Office Action by the number of months which will avoid abandonment under 37 C.F.R. § 1.135. The fee under 37 C.F.R. § 1.17 should be charged to our Deposit Account No. 15-0700.

AMENDMENTS

✓ If checked, amendment(s) to the specification and/or claims are submitted herewith.

1. Claims:

Please amend claims 4, 8, 10, 16-17 pursuant to 37 C.F.R. § 1.121(c)(i) as set forth in the “clean” version attached hereto as Appendix A. Entry is respectfully requested. A version with markings to show the changes made pursuant to 37 C.F.R. § 1.121(c)(ii) is attached hereto as Appendix B.

09560655-044702

REMARKS/ARGUMENT

The Preliminary Amendment is being submitted to change the multiple dependent claims to single dependent claims in order to eliminate the improper multiple dependent claims and to reduce the government filing fee.

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office Addressee (Mail Label EL 334668891US) in an envelope addressed to: U.S. Patent and Trademark Office, PO Box 2327, Arlington, VA 22202, on November 28, 2001

Dorothy Jenkins

Name of Person Mailing Correspondence

Dorothy Jenkins

Signature

November 28, 2001

Date of Signature

Respectfully submitted,

Robert C. Faber

Robert C. Faber

Registration No.: 24,322

OSTROLENK, FABER, GERB & SOFFEN, LLP

1180 Avenue of the Americas

New York, New York 10036-8403

Telephone: (212) 382-0700

RCF:sam/sjw

09980055-041702

APPENDIX A
“CLEAN” VERSION OF EACH PARAGRAPH/SECTION/CLAIM
37 C.F.R. § 1.121(b)(ii) AND (c)(i)

CLAIMS (with indication of amended or new):

4. (Amended) An interface device according to claim 1, wherein the planar member is manufactured from a glass material.

8. (Amended) An elongate member according to claim 6, wherein the coating is a hard coating.

10. (Amended) An interface device according to claim 1, wherein the elongate members for an interface device for providing an interface between testing equipment and an integrated circuit to be tested, the elongated member comprising a body portion and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

16. (Amended) A method according to claim 12, wherein the through bore to be formed in the piece of material is less than $100\mu\text{m}$.

17. (Amended) An interface device according to claim 1, wherein the apertures in the guide member are formed using a method of forming a through bore in a piece of material comprising generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

APPENDIX B
VERSION WITH MARKINGS TO SHOW CHANGES MADE
37 C.F.R. § 1.121(b)(iii) AND (c)(ii)

CLAIMS:

4. (Amended) An interface device according to [any of claims] claim 1 [to 3], wherein the planar member is manufactured from a glass material.

8. (Amended) An elongate member according to claim 6 [or claim 7], wherein the coating is a hard coating.

10. (Amended) An interface device according to [any of claims] claim 1 [to 5], wherein the elongate members [are in accordance with any of claims 6 to 9] for an interface device for providing an interface between testing equipment and an integrated circuit to be tested, the elongated member comprising a body portion and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

16. (Amended) A method according to [any of claims] claim 12 [to 15], wherein the through bore to be formed in the piece of material is less than 100 μ m.

17. (Amended) An interface device according to [any of claims] claim 1 [to 5, 10 or 11], wherein the apertures in the guide member are formed using a method [in accordance with any of claims 12 to 16] of forming a through bore in a piece of material comprising generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding

to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

20240505 04:17:02

2/pvt

AN INTERFACE DEVICE

The invention relates to an interface device for providing an interface between testing equipment and an integrated circuit to be tested using the testing equipment.

A probe card is used in semiconductor wafer fabrication and/or packaging facilities to test the integrity of every semiconductor chip (or die) produced. The process of testing involves testing equipment referred to as "probers" and an interface device that couples the testing equipment to the die to be tested. The interface device is commonly known as a "probe card". The probe card generally comprises a large number of probes, which take the form of pins. The pins are arranged on a printed circuit board, or other supporting structure, in a pattern that corresponds to the layout of the bonding pads on the die to be tested. Each die requires a probe card with a pin pattern that is specific to the layout of the bond pads on the die.

Test signals are exchanged between the prober and the die via the probe card and in particular, the pins that contact the bond pads on the die to be tested. The quality of signals received by the prober from the die is dependent on the quality of the probe card and the quality of contact between the pins and the bond pads on the die.

09/980055-041702

Conventional probe cards comprise a number of cantilevered probes fixed by epoxy resin to a ceramic or aluminium retaining ring. Typically, the free end of each cantilevered probe (ie the tip which contacts the bond pad) is overhanging the retaining ring by approximately 5mm to 6mm and there is an average pitch (ie spacing between the tips) of between 80µm to 200µm.

However, as chip geometries and resulting bond pad pitches are getting smaller and smaller (currently about 50µm) it is becoming increasingly difficult to design and build probecards using conventional cantilever pin designs.

Therefore, in order to achieve smaller probe pitches, smaller diameter wire is being used to manufacture the probes. However, using thinner wire has the disadvantage that the probes are substantially weaker and the overhanging cantilevered design of the probes makes them susceptible to lateral deflections at the tip. Therefore, the tips can not reliably maintain the correct x-y position. This has the risk that the tip may not contact the correct bond pad on the die during testing, resulting in the prober possibly giving an incorrect test result.

In accordance with a first aspect of the present invention, an interface device for providing an interface between

testing equipment and an integrated circuit to be tested comprises a body member; a number of elongate contact members, each elongate contact member comprising a contact end, adapted to contact a bond pad of an integrated circuit to be tested, and a body portion coupled to the body member; and a guide member mounted on the body member, the guide member comprising a substantially planar member having a number of apertures therein, the contact end of each elongate member extending through a respective aperture in the guide member, and the width of each contact end being less than the width of the respective aperture to permit lateral movement of each contact end within the respective aperture.

An advantage of the invention is that, as the contact end of each elongate member extends through a respective aperture in the guide member, the guide member limits lateral displacement of the contact ends.

Preferably, the planar member is manufactured from a glass material, such as borosilicate glass.

In accordance with a second aspect of the present invention, an elongate member for an interface device for providing an interface between testing equipment and an integrated circuit to be tested comprises a body portion

0996655-04309

and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

Preferably, the tip surface of the contact end is coated with the friction reducing coating.

Typically, the coating may be a hard coating, such as chrome nitride or titanium nitride.

Preferably, the elongate members in the first aspect are the elongate members in accordance with the second aspect of the invention. Typically, where the elongate members in the first aspect are in accordance with the elongate members in the second aspect, the side surfaces of the contact ends are coated with the friction reducing coating. This has the advantage of reducing friction between the side surfaces of the contact ends and the inside surfaces of the apertures in the guide member.

Preferably, the interface device further comprises a printed circuit board to which the ends of the contact members opposite to the contact ends are coupled and the printed circuit board is adapted to permit the testing equipment to be coupled to the printed circuit board.

0990055 044202

Preferably, the elongate contact member may be formed from metal wire with a diameter of 1 mil to 10 mil (25 μ m to 250 μ m) and is preferably in the region of 2 mil to 10 mil (50 μ m to 250 μ m). Typically, the contact surface of the contact ends may have a diameter of approximately 0.5 mil to 5 mils (12.5 μ m to 125 μ m) and preferable 1 mil to 2.5 mils (25 μ m to 62.5 μ m). The contact surface may be either planar or curved. Preferably, the contact members may be tungsten, beryllium copper, palladium, paliney or an alloy of two or more of these materials.

In accordance with a third aspect of the invention, a method of forming a through bore in a piece of material comprises generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

Preferably, the coherent light is generated by a laser, which may be an excimer laser. Typically, the light

generated by the excimer laser has a wavelength of approximately 193nm.

Typically, the object having the circular cross section may be a spherical object, such as a steel ball. Preferably, the object reflects the light incident on it to minimise heating of the object.

Typically, the through bore to be formed in the piece of material has a diameter less than 100 μ m and may be from 10 μ m to 100 μ m.

Preferably, the apertures in the guide member in the first aspect of the invention are formed using the method in accordance with the third aspect of the invention.

An example of an interface device in accordance with the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of a section of an interface device including a guide member;

Figure 2 is a side view of a portion of the interface device; and

Figure 3 is a schematic view of apparatus for forming apertures in the guide member forming part of the

interface device shown in Figures 1 and 2.

Figure 1 shows a schematic view of a portion of a probe card 2. The probe card 2 includes a ring 1 formed from ceramic, aluminium or titanium, a guide member in the form of a glass wafer 3 and a number of contact pins 5 mounted on the ring 1 by means of a ceramic shim 6 and epoxy resin 7.

As shown in more detail in Figure 2, each of the contact pins 5 comprises a central body portion 10 which rests on and is fixed to the ceramic shim 6, a contact end 13 and a PCB end 12 which is electrically coupled by solder 20 to a trace 22 on a printed circuit board (PCB) 21.

The contact pins 5 are typically manufactured from a metal wire such as tungsten, beryllium copper, palladium, paliney alloy or any other suitable metal material. The contact pins 5 can also be comprised of a suitable base metal with another metal coated on this base metal. The wire diameter is typically in the region of 1 mil to 10 mil (25µm to 250µm) and the surface of the contact end 13 may have a diameter of approximately 1 mil to 2.5 mil (25µm to 62.5µm) with a flat or curved surface. In addition, the contact end 13 is etched to form a taper.

The glass wafer 3 is typically a borosilicate glass and has micro holes 16 therein which may be formed by laser drilling, and the contact end 13 protrudes through the micro holes 16.

Preferably, the contact ends 13 of the pins 5 are coated with a hard coating, such as chrome nitride or titanium nitride. This has the advantage of reducing friction between the contact surface or tip of the contact pins and the bond pads on a die being tested, which improves tip life. In addition, if the sides of the contact ends 13 are also coated, this reduces friction between the sides of the contact ends and the inside surfaces of the apertures 16.

Preferably, the laser drilling is performed using an optical arrangement as shown in Figure 3. An excimer laser 30 emits light with a wavelength of 193nm and an energy of 200mJ per pulse. The light beam from the laser is then collimated by collimating optics 31 to form a collimated beam of light with a circular cross-section. A steel ball 32 is fixed to a glass plate 33. The steel ball 32 has a diameter which is less than that of the output beam from the collimating optics. Therefore, when the centre of the collimated beam strikes the center of the steel ball, the central portion of the collimated beam is reflected and scattered from the steel ball but the outermost section of

00000055.000000

the collimated beam passes by the steel ball 32 undeviated and passes through the glass plate 33. Hence, the steel ball 32 forms an optical mask, the output beam from which is a collimated annular beam. The collimated annular beam is then focused by focusing optics 34 onto the glass wafer 3 to burn an annular ring in the glass wafer 3 to form an aperture 16.

In order to form an aperture 6, the laser 30 typically operates at a pulse rate of 50 Hz for 20s. However, this will depend on a number of factors such as the thickness of the wafer 3 and the type of glass from which the wafer 3 is formed.

The invention has the advantages that by using the glass wafer 3 as a guide member, the apertures 16 limit lateral displacement of the contact ends 13. This permits thinner diameter wire to be used for the pins 5 which enables higher pitch densities for the pins 5 to be achieved while still maintaining the lateral position of the contact ends.

In addition, as the axis of the apertures 16 is substantially vertical, vertical movement of the contact ends 13 is not affected by the presence of the glass wafer 3.

CLAIMS

1. An interface device for providing an interface between testing equipment and an integrated circuit to be tested, the interface device comprising a body member; a number of elongate contact members, each elongate contact member comprising a contact end, adapted to contact a bond pad of an integrated circuit to be tested, and a body portion coupled to the body member; and a guide member mounted on the body member, the guide member comprising a substantially planar member having a number of apertures therein, the contact end of each elongate member extending through a respective aperture in the guide member, and the width of each contact end being less than the width of the respective aperture to permit lateral movement of each contact end within the respective aperture.

2. An interface device according to claim 1, wherein the elongate contact member is formed from metal wire with a diameter of 1 mil to 10 mil (25 μ m to 250 μ m).

3. An interface device according to claim 2, wherein the elongate contact member has a diameter of between 1 mil to 6 mils (25 μ m to 150 μ m).

4. An interface device according to any of claims 1 to 3,

wherein the planar member is manufactured from a glass material.

5. An interface device according to claim 4, wherein the glass material is borosilicate glass.

6. An elongate member for an interface device for providing an interface between testing equipment and an integrated circuit to be tested, the elongate member comprising a body portion and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

7. An elongate member according to claim 6, wherein the tip surface of the contact ends is coated with the friction reducing coating.

8. An elongate member according to claim 6 or claim 7, wherein the coating is a hard coating.

9. An elongate member according to claim 8, wherein the hard coating is selected from chrome nitride and titanium nitride.

10. An interface device according to any of claims 1 to 5,

wherein the elongate members are in accordance with any of claims 6 to 9.

11. An interface device according to claim 10, wherein the side surfaces of the contact ends are coated with the friction reducing coating.

12. A method of forming a through bore in a piece of material comprising generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

13. A method according to claim 12, wherein the coherent light is generated by a laser.

14. A method according to claim 13, wherein the laser light is generated by an excimer laser.

15. A method according to claim 14, wherein the light

0998885-04709

generated by the excimer laser has a wavelength of approximately 193nm.

16. A method according to any of claims 12 to 15, wherein the through bore to be formed in the piece of material is less than 100 μ m.

17. An interface device according to any of claims 1 to 5, 10 or 11, wherein the apertures in the guide member are formed using a method in accordance with any of claims 12 to 16.

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
7 December 2000 (07.12.2000)

(10) International Publication Number
WO 00/74108 A2

PCT

- (51) **International Patent Classification⁷:** **H01L**

(21) **International Application Number:** PCT/SG99/00048

(22) **International Filing Date:** 28 May 1999 (28.05.1999)

(25) **Filing Language:** English

(26) **Publication Language:** English

(71) **Applicant (for all designated States except US):** **SPIRE TECHNOLOGIES PTE LTD.** [SG/SG]; 21 Kallang Avenue #06-169/171, Singapore 339412 (SG).

(72) **Inventors; and**

(75) **Inventors/Applicants (for US only):** **SAWHILL, Robert, Arthur, Jr.** [US/SG]; 2 Hillview Way, Singapore 669173 (SG). **SHAH, Paren, Indravadan** [IN/SG]; 10 Rose Lane #01-01, Singapore 429076 (SG).

(74) **Agent:** **MCCALLUM, Graeme, David;** Lloyd Wise, Tanjong Pagar, P.O. Box 636, Singapore 910816 (SG).

(81) **Designated States (national):** AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States (regional):** ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *Without international search report and to be republished upon receipt of that report.*

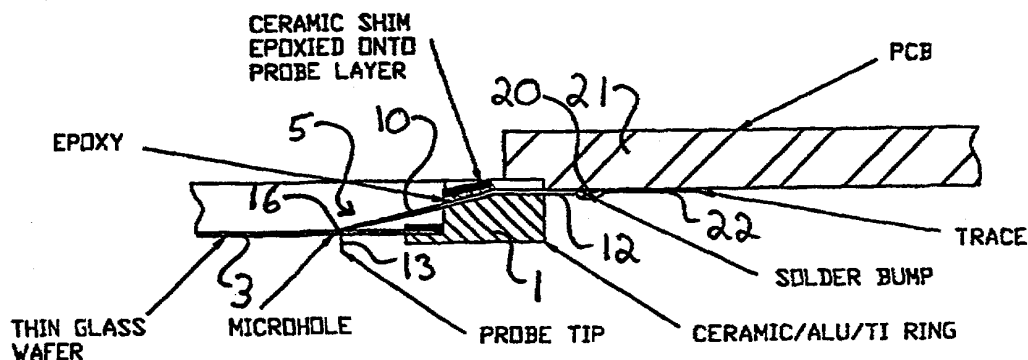
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— Without international search report and to be republished upon receipt of that report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AN INTERFACE DEVICE



(57) **Abstract:** An interface device (2) provides an interface between testing equipment and an integrated circuit to be tested. The interface device (2) includes a body member (7). A number of elongate contact members (5) are mounted on the body member (7). Each contact member (5) includes a contact end (10), adapted to contact a bond pad of the integrated circuit to be tested, and a body portion (11). The interface device also includes a guide member mounted on the body member (7). The guide member includes a substantially planar member having a number of apertures therein, and the contact end of each elongate member extending through a respective aperture in the guide member.

SECRET

WO 00/74108 A2

1/2

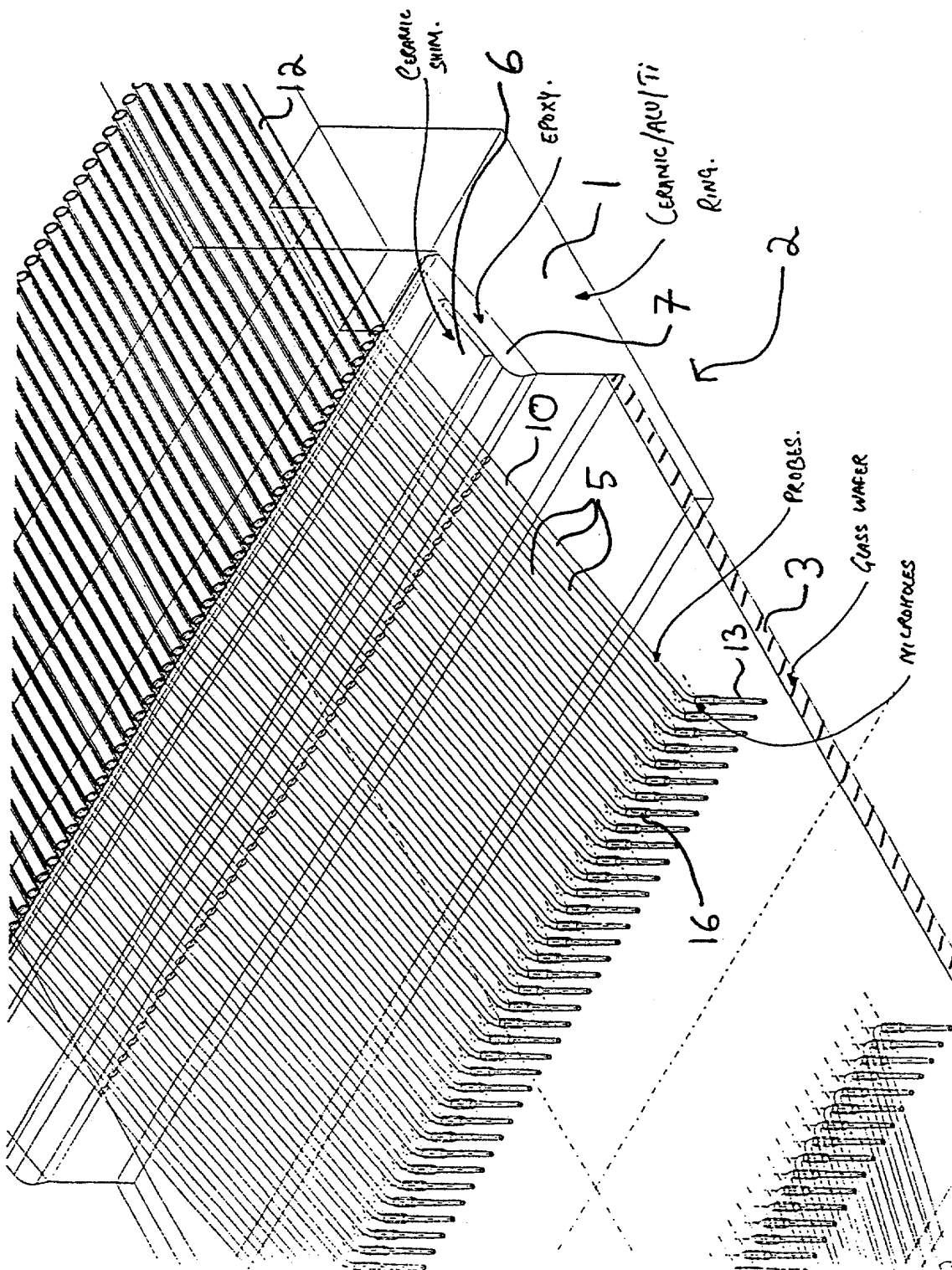


Figure 1

09/980055-64702

2/2

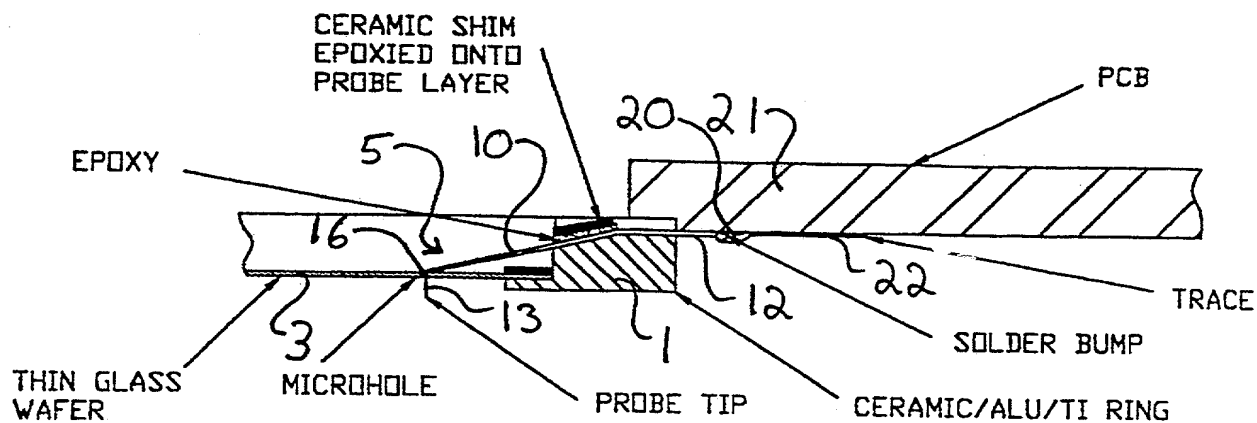


FIGURE 2

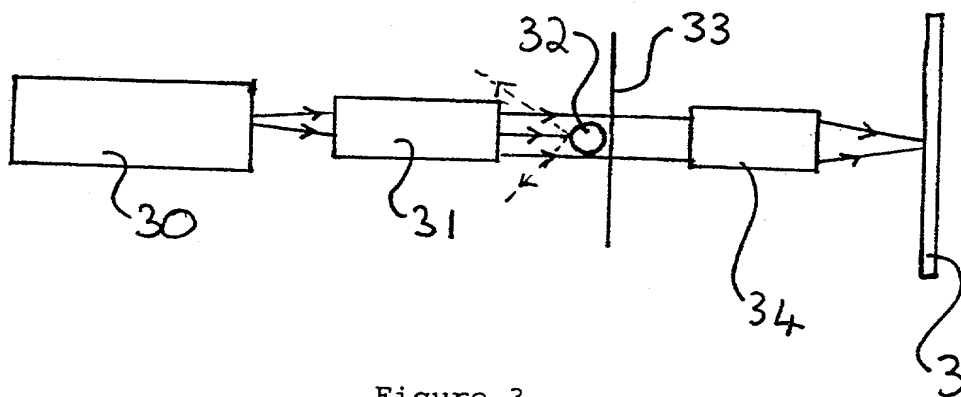


Figure 3

09980055-044702

UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION		OFGS FILE NO. P/2778-21																																																	
<p>As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:</p> <p>AN INTERFACE DEVICE</p> <p>the specification of which is attached hereto, unless the following box is checked:</p> <p><input checked="" type="checkbox"/> was filed on <u>28 May 1999</u> as United States patent Application Number or PCT International patent application number <u>PCT/SG99/00048</u> and was amended on _____ (if any).</p> <p>I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.</p> <p>I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.</p> <p>I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:</p> <p>Prior Foreign or Provisional Application(s)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%;">COUNTRY</th> <th style="width: 25%;">APPLICATION NUMBER</th> <th style="width: 25%;">DATE OF FILING (day, month, year)</th> <th style="width: 25%;">PRIORITY CLAIMED UNDER 35 U.S.C. 119</th> </tr> <tr> <td>PCT</td> <td>PCT/SG99/00048</td> <td>28 May 1999</td> <td>YES <u>X</u> NO ____</td> </tr> <tr> <td></td> <td></td> <td></td> <td>YES ____ NO ____</td> </tr> </table> <p>I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%;">UNITED STATES APPLICATION NUMBER</th> <th style="width: 30%;">DATE OF FILING (day, month, year)</th> <th style="width: 40%;">STATUS (patented, pending, abandoned)</th> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </table> <p>I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berliner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944; Louis C. Dujmich - Reg. No. 30,625; Douglas A. Miro - Reg. No. 31,643, and Michael J. Scher - Reg. No. 34,425, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence.</p> <p>SEND CORRESPONDENCE TO: OSTROLENK, FABER, GERB & SOFFEN, LLP DIRECT TELEPHONE CALLS TO: 1180 AVENUE OF THE AMERICAS (212) 382-0700 NEW YORK, NEW YORK 10036-8403 CUSTOMER NO. 2352</p> <p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 35%;">FULL NAME OF SOLE OR FIRST INVENTOR Robert Arthur SAWHILL, Jr.</td> <td style="width: 30%;">INVENTOR'S SIGNATURE</td> <td style="width: 35%;">DATE</td> </tr> <tr> <td colspan="2">RESIDENCE (City and either State or Foreign Country) Singapore 669173, Singapore</td> <td>COUNTRY OF CITIZENSHIP United States</td> </tr> <tr> <td colspan="3">POST OFFICE ADDRESS 2 Hillview Way, Singapore 669173, Singapore</td> </tr> <tr> <td>FULL NAME OF SECOND JOINT INVENTOR (IF ANY) Paren Indravadan SHAH</td> <td>INVENTOR'S SIGNATURE</td> <td>DATE</td> </tr> <tr> <td colspan="2">RESIDENCE (City and either State or Foreign Country) Singapore 429076, Singapore</td> <td>COUNTRY OF CITIZENSHIP India</td> </tr> <tr> <td colspan="3">POST OFFICE ADDRESS 10 Rose Lane #01-01, Singapore 429076, Singapore</td> </tr> <tr> <td>FULL NAME OF THIRD JOINT INVENTOR (IF ANY)</td> <td>INVENTOR'S SIGNATURE</td> <td>DATE</td> </tr> <tr> <td colspan="2">RESIDENCE (City and either State or Foreign Country)</td> <td>COUNTRY OF CITIZENSHIP</td> </tr> <tr> <td colspan="3">POST OFFICE ADDRESS</td> </tr> </table>				COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119	PCT	PCT/SG99/00048	28 May 1999	YES <u>X</u> NO ____				YES ____ NO ____	UNITED STATES APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)							FULL NAME OF SOLE OR FIRST INVENTOR Robert Arthur SAWHILL, Jr.	INVENTOR'S SIGNATURE	DATE	RESIDENCE (City and either State or Foreign Country) Singapore 669173, Singapore		COUNTRY OF CITIZENSHIP United States	POST OFFICE ADDRESS 2 Hillview Way, Singapore 669173, Singapore			FULL NAME OF SECOND JOINT INVENTOR (IF ANY) Paren Indravadan SHAH	INVENTOR'S SIGNATURE	DATE	RESIDENCE (City and either State or Foreign Country) Singapore 429076, Singapore		COUNTRY OF CITIZENSHIP India	POST OFFICE ADDRESS 10 Rose Lane #01-01, Singapore 429076, Singapore			FULL NAME OF THIRD JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE	RESIDENCE (City and either State or Foreign Country)		COUNTRY OF CITIZENSHIP	POST OFFICE ADDRESS		
COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119																																																
PCT	PCT/SG99/00048	28 May 1999	YES <u>X</u> NO ____																																																
			YES ____ NO ____																																																
UNITED STATES APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)																																																	
FULL NAME OF SOLE OR FIRST INVENTOR Robert Arthur SAWHILL, Jr.	INVENTOR'S SIGNATURE	DATE																																																	
RESIDENCE (City and either State or Foreign Country) Singapore 669173, Singapore		COUNTRY OF CITIZENSHIP United States																																																	
POST OFFICE ADDRESS 2 Hillview Way, Singapore 669173, Singapore																																																			
FULL NAME OF SECOND JOINT INVENTOR (IF ANY) Paren Indravadan SHAH	INVENTOR'S SIGNATURE	DATE																																																	
RESIDENCE (City and either State or Foreign Country) Singapore 429076, Singapore		COUNTRY OF CITIZENSHIP India																																																	
POST OFFICE ADDRESS 10 Rose Lane #01-01, Singapore 429076, Singapore																																																			
FULL NAME OF THIRD JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE																																																	
RESIDENCE (City and either State or Foreign Country)		COUNTRY OF CITIZENSHIP																																																	
POST OFFICE ADDRESS																																																			

☐ CONTINUED ON PAGE 2

1/2

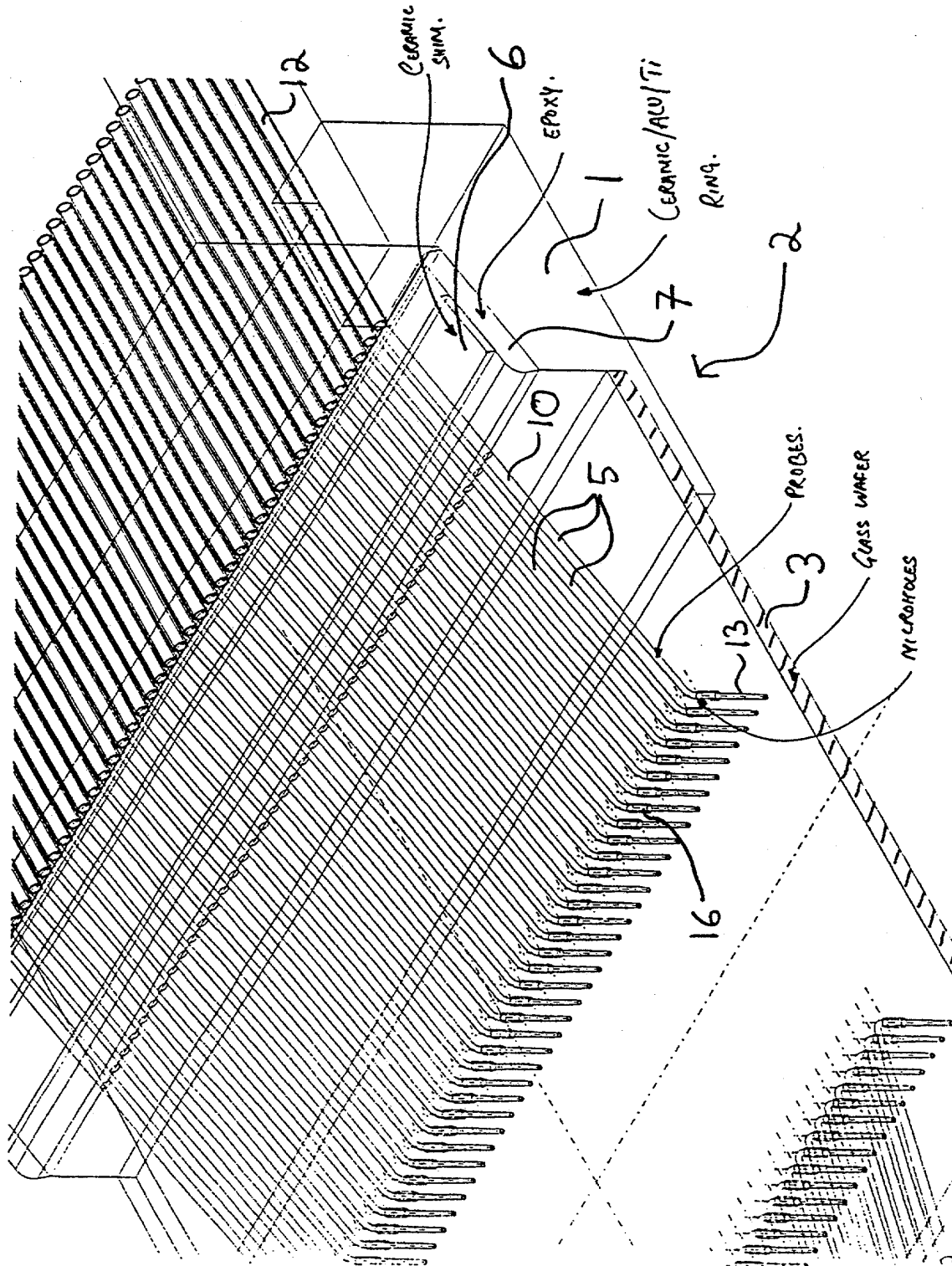


Figure 1

202740-55008660

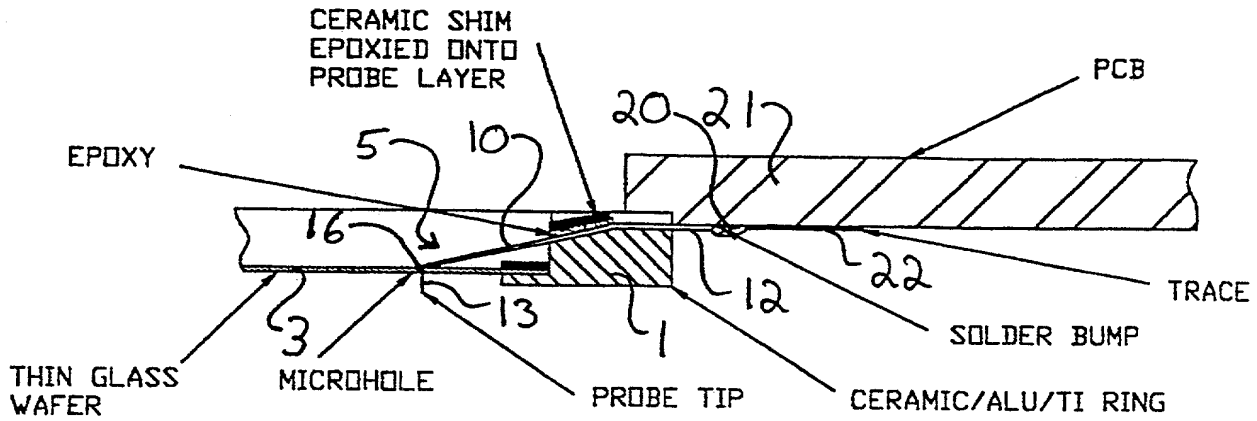


FIGURE 2

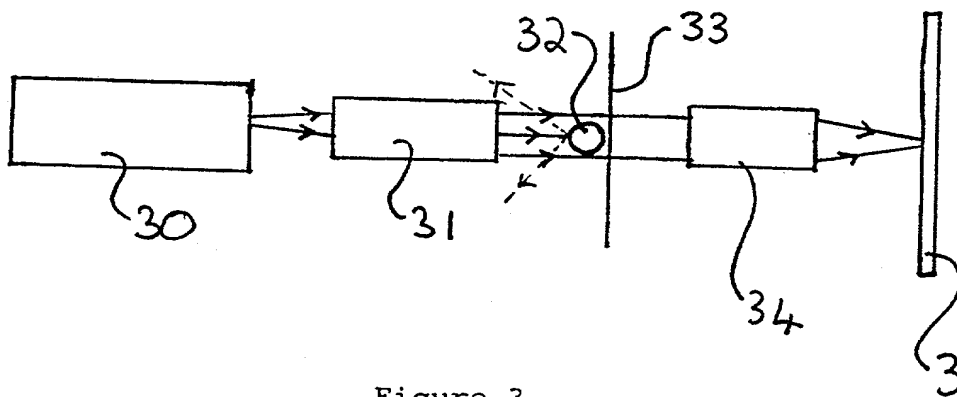


Figure 3

17 APR 2002
OFPS FILE NO.
P/2778-21

UNITED STATES OF AMERICA
COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

AN INTERFACE DEVICE

the specification of which is attached hereto, unless the following box is checked:

☒ was filed on 28 May 1999 as United States patent Application Number or PCT International patent application number PCT/SG99/00048 and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. 119
PCT	PCT/SG99/00048	28 May 1999	YES <u>X</u> NO _____
			YES _____ NO _____

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No. 18,510; Jerome M. Berlner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,473; William O. Gray, III - Reg. No. 30,944; Louis C. Dujmich - Reg. No. 30,625; Douglas A. Miro - Reg. No. 31,643, and Michael J. Scheer - Reg. No. 34,425, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence.

SEND CORRESPONDENCE TO:

OSTROLENK, FABER, GERB & SOFFEN, LLP
1180 AVENUE OF THE AMERICAS
NEW YORK, NEW YORK 10036-8403
CUSTOMER NO. 2352

DIRECT TELEPHONE CALLS TO:
(212) 382-0700

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR <u>Robert Arthur SAWHILL, Jr.</u>	INVENTOR'S SIGNATURE <u>[Signature]</u>	DATE <u>FEB. 28, 2002</u>
RESIDENCE (City and either State or Foreign Country) <u>Singapore 738254, Singapore</u>	<u>SOX</u>	COUNTRY OF CITIZENSHIP <u>United States</u>
POST OFFICE ADDRESS <u>45 Pinewood Grove</u>		
FULL NAME OF SECOND JOINT INVENTOR (IF ANY) <u>Paren Indravadan SHAH</u>	INVENTOR'S SIGNATURE <u>[Signature]</u>	DATE <u>APR 03, 2002</u>
RESIDENCE (City and either State or Foreign Country) <u>Sunnyvale, California 94087</u>	<u>SOX</u>	COUNTRY OF CITIZENSHIP <u>India SINGAPORE</u>
POST OFFICE ADDRESS <u>555 East El Camino Real #610, Sunnyvale, California 94087</u>		
FULL NAME OF THIRD JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE
RESIDENCE (City and either State or Foreign Country)		COUNTRY OF CITIZENSHIP
POST OFFICE ADDRESS		

☐ CONTINUED ON PAGE 2